United Nations Development Program: Millenium Development Goals, Samoa

Chapter 1
Introduction

Summary

- People living in small tropical islands are experiencing changes and variability in their climate that are affecting their environment, culture and livelihoods.
- Focusing on the western Pacific region, and especially the independent Pacific countries and East Timor, this scientific assessment and new research builds on the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007). Detailed analyses and new research relating to the current climate, observed variability and trends, and climate change projections are presented.
- Extensive analysis of the performance of 24 global climate models identified a set of 18 models which provide a reasonable representation of climate over the Pacific Islands and East Timor. These 18 models were used to construct climate change projections for three emissions scenarios: A2 (high), A1B (medium) and B1 (low); and three future 20-year periods centred on 2030, 2055 and 2090, relative to a 20-year period centred on 1990. Downscaling techniques were used to provide more detail for selected regions.
- This scientific assessment and new research has been undertaken as part of the Pacific Climate Change Science Program (PCCSP), a component of the Australian Government's International Climate Change Adaptation Initiative.
- The PCCSP is a collaborative research partnership between Australian Government agencies, 14 Pacific Island countries and East Timor, and regional and international organisations. The 14 Pacific countries are: Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu. The 15 Partner Countries are immensely diverse in terms of their history, geography, climate, natural resource base and culture.
- The PCCSP addresses two of the key principles of the Pacific Islands Framework for Action on Climate Change 2006–2015 (Secretariat of the Pacific Regional Environment Programme, 2005): improving the understanding of climate change; and provision of education, training and awareness.
- This publication is designed to provide decision makers and other stakeholders within the Pacific Island countries and East Timor, as well as the wider scientific community, with up-to-date, robust climate change science information for the PCCSP region (Volume 1) and for individual PCCSP Partner Countries (Volume 2).

1.1 Background

This chapter sets the contextual background and outlines the framework for the science presented in this publication.

People living in small tropical islands are experiencing changes and variability in their climate such as shifts in rainfall patterns, increasing frequency of some extreme weather events and rising sea levels. These changes are affecting peoples' environment, culture and livelihoods, as well as important economic sectors such as agriculture and tourism.

Scientists are working to understand these changes and how they reflect natural climate variability and changes due directly or indirectly to human activity that alters the composition of the global atmosphere.

Distinguishing between natural variability and climate change due to human activity is extremely difficult. Throughout these two volumes the definition of climate change in the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC, 2007) is used (Box 1.1). A more detailed definition is presented in the Glossary. This definition includes changes due to natural variability and changes resulting from human activity. Climate is defined as the average weather over 30 years or more. In different chapters in this publication, different averaging periods, such as 20 years, are also used.

Box1.1: Definition of Climate and Climate Change

Climate change refers to a change in the state of the climate that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer (IPCC, 2007).

Climate is usually defined as the average weather over 30 years or more. In different chapters in this publication, different averaging periods, such as 20 years, are also used.

Focusing on the western Pacific region, and especially the independent Pacific countries and East Timor, the scientific assessment and the new research presented in these two volumes builds on the Fourth Assessment Report of the IPCC (IPCC, 2007) and other research undertaken since 2007, e.g. the recently published research on climate change and fisheries (Bell et al., 2011). These volumes analyse the current climate, observed variability and climate trends, and further develop climate change projections for the region and individual countries. The research was been undertaken between 2009 and 2011 as part of the Pacific Climate Change Science Program (PCCSP), a key component of the Australian Government's International Climate Change Adaptation Initiative. The information presented here will provide decision makers, other stakeholders in the Partner Countries and the wider scientific community, with up-to-date, robust, climate change science information. Volume 1 presents a regional overview and Volume 2 presents individual country reports. A Glossary of terms is presented at the end of each volume.

1.2 Contextual Setting

Building on a foundation of regional and international agreements, and in recognition of the seriousness of the adverse effects of climate change, the Pacific Island Countries and Territories developed the Pacific Islands Framework for Action on Climate Change 2006–2015, which was released in June 2006.

The goal of this Framework is to "ensure that Pacific Island people build their capacity to be resilient to the risks and impacts of climate change" with the key objective to deliver on the expected outcomes under the following principles:

- Implementing adaptation measures.
- Governance and decision making.
- Improving understanding of climate change.
- Education, training and awareness.
- Contributing to global greenhouse gas reduction.
- Partnerships and cooperation.

The Intergovernmental Panel on Climate Change's Fourth Assessment Report (IPCC, 2007) found significant research gaps which needed to be filled to better inform climate change adaptation and resilience building in small island developing States. The report identified a number of information gaps and research priorities, noting in particular that many small islands lacked adequate observational data, and that output from global climate models was not of sufficiently fine resolution to provide specific information for islands.

In 2008, the Australian Government launched the International Climate Change Adaptation Initiative to meet high-priority adaptation needs of vulnerable countries within the Asia-Pacific region.

The objectives of the International Climate Change Adaptation Initiative are to:

- Establish a sound policy, scientific and analytical basis for long-term Australian action to help Partner Countries adapt to the impacts of climate change.
- Increase Partner Country understanding of the impacts of climate change on their natural and socio-economic systems.
- Enhance Partner Country capacity to assess key climate vulnerabilities and risks, formulate appropriate adaptation strategies and plans, and mainstream adaptation into decision making.
- Identify and finance priority adaptation measures that can immediately increase the resilience of Partner Countries to the impacts of climate change.

The PCCSP is contributing to the International Climate Change Adaptation Initiative by providing scientific information and improved understanding so the Partner Countries can better prepare for the future.

1.2.1 Pacific Climate Change Science Program

The PCCSP is a collaborative research partnership between Australian Government agencies and 14 Pacific Island countries and East Timor, carried out in collaboration with regional and international organisations.

Guided by the Australian Agency for International Development and the Australian Department of Climate Change and Energy Efficiency, the PCCSP is delivered by the Australian Bureau of Meteorology and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) through their research partnership in the Centre for Australian Weather and Climate Research.

The PCCSP addresses two of the key principles of the Pacific Islands Framework for Action on Climate Change 2006–2015: improving the understanding of climate change (principle 3); and the provision of education, training and awareness (principle 4).

The PCCSP's primary objective is to conduct a comprehensive climate change science research program aimed at providing in-depth information about past, current and future climates in Partner Countries. Specific objectives are to:

- Undertake meteorological, climatological and oceanographic research, particularly in areas where there are identified gaps in Partner Country knowledge.

- Build the capacity of each Partner Country's national meteorological service and scientific organisations, where feasible, to undertake scientific research.
- Disseminate the information to Partner Country stakeholders and other parties.

Box 1.2 shows how these three objectives are interlinked.

The PCCSP recognises that this research must be delivered to Partner Countries in practical and relevant ways to be useful to decision makers. Partner Country engagement, information sharing and capacity building have been undertaken in a coordinated way across all areas of research. Besides this publication, other PCCSP products include:

- Two regional brochures, one focusing on the PCCSP and the second on climate variability and change.
- Fifteen country-specific brochures outlining past, current and future climate, targeted towards a general audience and produced in English and local languages.
- Fifteen country-specific posters.
- A database management system and three web-based tools for improved analysis of past, current and future climate and supplemented by user manuals and fact sheets. These products provide for information sharing among different levels of users.
- An extensive program of training, capacity building and engagement with island stakeholders, especially representatives of the respective national meteorological services.

1.2.2 Partner Country Diversity

The Pacific Islands are immensely diverse in terms of their history, geography, climate, natural resource base and culture. The Pacific Islands may be divided culturally into three main groups: Melanesia, Polynesia and Micronesia. East Timor is one of the Sunda Islands at the eastern end of the Indonesian Archipelago.

Historically, the 15 Partner Countries belong to the group of small-island developing States (SIDS), a group of low-lying coastal countries that share many similar sustainable development challenges such as small populations, limited resources, remoteness, susceptibility to natural disasters, vulnerability to external shocks and dependence on international trade (www.un.org/esa/dsd/dsd_aofw_sids/sids_members.shtml). SIDS were first recognised as a distinct group of developing countries at the United Nations Conference on Environment and Development in June 1992.

Table 1.1 provides a summary of selected characteristics for the 15 Partner Countries and illustrates their diversity.

Box 1.2: Description of the Pacific Climate Change Science Program

Retrieving, managing and analysing climate data, and understanding major climate phenomena such as the El Niño-Southern Oscillation

Analysing and downscaling global climate models to prepare projections of how the atmosphere and oceans may change around 2030, 2055 and 2090

Partner Country engagement to build local capacity in climate science, and atmosphere and oceans projections; and the preparation of a scientific assessment, country reports, brochures and posters

Table 1.1: Characteristics of the PCCSP Partner Countries

Country	Capital	Land area (km^2)	Exclusive economic zone area (million km^2)	Maximum height above sea level (m)	Population (2010 estimate except Vanuatu)	Languages	Government
Cook Islands	Avarua	237	1.8	652	11 500	English, Maori	Semi-independent country in free association with New Zealand
East Timor	Dili	15 007	Under determination	2 963	1 066 582	Portuguese and Tétum + 15 local dialects. (Working languages: English and Bahasa Indonesian)	Republic
Federated States of Micronesia	Palikir	702	2.98	791	111 364	English, Chuukese, Pohnpeian, Yapese	Independent with free association arrangements with USA until 2023
Fiji	Suva	18 333	1.3	1 300	844 420	English, Fijian, Hindi	Independent state
Kiribati	South Tarawa	811	3.6	87	100 835	I-Kiribati, English	Democratic republic
Marshall Islands	Majuro	181	1.81	3	54 439	Marshallese, English	Republic in free association with the USA
Nauru	No official capital. Yaren District (largest settlement)	21	0.32	70	9 976	Nauruan, English	Republic with parliamentary system
Niue	Alofi	259	0.39	69	1 470	Niuean, English	Free association with New Zealand
Palau	Melekeok	535	0.63	214	20 518	Palauan, English	Independent nation in free association with the USA
Papua New Guinea	Port Moresby	462 243	3.12	4 697	6 744 955	Tok Pisin, English + more than 700 other languages	Independent state
Samoa	Apia	2 934	0.12	1 860	183 123	Samoan, English	Independent state
Solomon Islands	Honiara	28 785	1.34	2 447	549 574	English, Pidgin + 87 other languages	Independent state
Tonga	Nuku'alofa	748	0.72	1 030	103 365	Tongan, English	Independent kingdom
Tuvalu	Funafuti	26	0.9	5	11 149	Tuvaluan, English	Independent state
Vanuatu	Port Vila	12 281	0.71	1 877	234 023 (2009)	Bislama, French, English + 105 other languages	Republic

Sources for Table 1.1 data:

- List of individual country statistics, Secretariat of the Pacific Community Applied Geoscience and Technology Division (SOPAC); http://www.sopac.org/index.php/member-countries
- List of individual countries' First National Communication under the United Nations Framework Convention on Climate Change (UNFCCC); http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php
- Country statistics for East Timor; http://timor-leste.gov.tl/?p=547&lang=e; and http://www.dfat.gov.au/geo/east_timor/east_timor_brief.html

1.3 Building on the Fourth Assessment Report of the IPCC

Key findings relating to the Pacific, as defined by the region between 20°N and 30°S and 120°E to 120°W, from the Fourth Assessment Report (IPCC, 2007) include the following:

- The main climatic processes that play a role in the climate of this region are the easterly trade winds, the Southern Hemisphere high pressure belt, the Intertropical Convergence Zone (ITCZ) and the South Pacific Convergence Zone (SPCZ).
- Year-to-year climatic variability is very strongly affected by the El Niño-Southern Oscillation (ENSO).
- Global climate models do not have sufficiently fine resolution to represent the small islands and very little work has been done to represent important island effects resulting from island shape and topography using techniques such as downscaling. Some climatic processes are still not well understood.
- The ability of the multi-model dataset models to simulate present climate in the Pacific is satisfactory for temperature simulations, however, there are large spreads in precipitation simulations. There are systematic errors in simulating mean climate and natural variability.
- All North and South Pacific Islands are very likely to warm during this century. The warming is likely to be somewhat smaller than the global annual mean warming in all seasons.
- Annual rainfall is likely to increase in the equatorial Pacific, while most models project decreases just east of French Polynesia in December-February.
- There is much less certainty about changes in frequency and intensity of tropical cyclones on a regional basis than for temperature and precipitation changes. There is no clear picture with respect to regional changes in frequency and movement, but increases in intensity are indicated. ENSO fluctuations have a strong impact on patterns of tropical cyclone occurrence in the South Pacific, and uncertainty with respect to future ENSO behaviour contributes to uncertainty with respect to tropical cyclone behaviour.
- Sea levels are likely to continue to rise, on average, during the 21st century. Models indicate that the rise will not be geographically uniform. Large deviations among models make regional estimates across the Pacific Ocean uncertain.

1.4 Major New Contributions to Pacific Climate Change Science

Building on the findings of the IPCC (2007) Fourth Assessment Report, the PCCSP has assessed recent literature and conducted new research. Attention is primarily focused on the region defined by the coordinates 25°S–20°N and 120°E–150°W (excluding the Australian region south of 10°S and west of 155°E). This region is referred to in this publication as the PCCSP region and differs slightly from the region defined in the IPCC Fourth Assessment Report (2007). The PCCSP region includes the 14 independent Pacific Islands labelled in Figure 1.1 and East Timor.

The research and new findings presented in these two volumes represent the first comprehensive climate change science research program for the independent Pacific Islands and East Timor and complements other research such as the recently published, 'Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change', (Bell et al., 2011). As such it covers new ground for the PCCSP region as a whole (Volume 1) and especially for the individual island countries (Volume 2). Recognising the diversity among the islands, the second volume of this publication presents reports for each of the 15 Partner Countries. Each report details their seasonal and annual climate cycles including extreme events, observed trends and climate variability. The reports also include projections for several atmospheric and ocean variables (temperature, rainfall, wind speed, extreme events, sea-surface temperature, ocean acidification and sea-level rise) for three future 20-year periods centred on 2030, 2055 and 2090, and for three emissions scenarios from the IPCC Special Report on Emissions Scenarios (SRES): B1 (low), A1B (medium) and A2 (high).

The findings are, to a large extent, based on data from weather and ocean-observing stations together with regional and global gridded data based on in-situ and satellite data. In collaboration with Partner Country meteorological services, extensive work has been done to retrieve and analyse these data and ensure that they are of the highest possible quality.

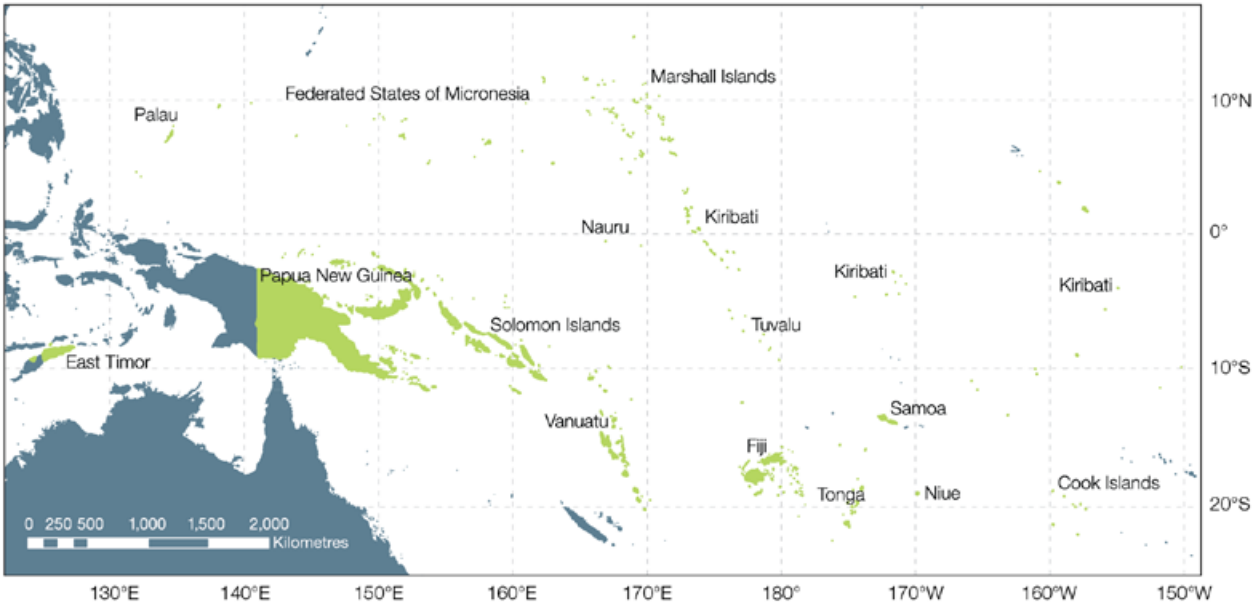

Figure 1.1: PCCSP region and Partner Countries: Cook Islands, East Timor, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu

A number of major advances have been made over the course of the PCCSP, making this publication the most comprehensive assessment of Pacific climate change science to date. Advances include:

- A detailed assessment of observed changes in Partner Country climate showing a climate in constant transition over the past 50 years with fluctuations in patterns of variability, such as ENSO, and in large-scale climatological features, such as SPCZ, driving the variability on seasonal to decadal time scales (Chapters 2 and 3).
- Extensive analysis of the performance of 24 global climate models identified a set of 18 models which provide a reasonable representation of climate over the PCCSP region (Chapters 4 and 5).
- Projections for six atmospheric variables: air temperature, rainfall, relative humidity, potential evapotranspiration, solar radiation and wind; and four ocean variables: sea-surface temperature, sea-surface salinity, sea level and ocean acidification, based on up to 18 models and three emissions scenarios, as well as projected changes in key large-scale climate features and patterns of variability (Chapter 6).
- Enhanced resolution of model output using both dynamical and statistical downscaling methods to complement the projections from the global climate models (Chapter 7).
- Projected changes in the frequency and intensity of tropical cyclones based on model downscaling (Chapter 7).

While the PCCSP has sought to address some of the key gaps identified in the IPCC Fourth Assessment Report (IPCC, 2007), there still remain several areas requiring further work (Chapter 8). These include:

- Expansion of the land and ocean-based climate observational networks and the rescue and rehabilitation of historical climate data.
- Enhanced understanding of large-scale climate features, patterns of variability and the detection and attribution of climate change.
- Continual improvement and assessment of climate models so as to provide progressively more robust projections of atmospheric and ocean variables.